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AUTHOR Groves, Fred H.; Pugh, Ava F.
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ABSTRACT

Elementary and secondary students hold a variety of misunderstandings regarding environmental problems, some of which may arise from misunderstandings held by their teachers. This study used the Environmental Issues Questionnaire to examine understandings of the greenhouse effect held by elementary education majors and other college majors (N=330) to see if misunderstandings of grade school students are perpetuated at the college level. Demographic variables that were considered included gender, class level, college assignment, teaching background, grade point average (GPA), age, race/ethnic group, state residency, and highest earned degree. Results indicate that overall, males outscored females but there were no significant differences between male and female education and liberal arts majors. The science students and liberal arts majors scored significantly higher than the education majors. For class level, GPA, age, and highest degree earned, significant differences were found for education majors, but not for science and liberal arts majors. It was concluded that elementary education majors correctly recognized some of the major potential effects of global warming but confused this problem with other issues like ozone depletion, radiation pollution and nuclear bombs, acid rain, earthquakes, biodiversity, and water pollution. (JRH)

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THE RELATIONSHIP OF COLLEGE STUDENT PERCEPTIONS OF GLOBAL WARMING TO NINE DEMOGRAPHIC VARIABLES

Fred H. Groves

Ava F. Pugh

College of Education

Northeast Louisiana University

Monroe, LA 71209

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F Groves
A Pugh

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Problem

Elementary and secondary students hold a variety of misunderstandings regarding environmental problems (Phillips, 1991), some of which may arise from misunderstandings held by their teachers. This study used the Environmental Issues Questionnaire developed by Boyes, Chuckran, and Stanisstreet (1993) to examine understanding of the "greenhouse effect" held by elementary education majors and other college majors to see if misunderstandings of grade school students are perpetuated at the college level.

Rationale

Both in America and Europe, the general public has developed an increasing awareness of world environmental problems; and one of the most acknowledged concerns is that known as the "greenhouse effect". Currently, students encounter these issues in their science classes at various points during their K-12 school experiences, and also in many college courses. These issues are also addressed in the printed media and through television programs. Even so, many aspects of the greenhouse effect are still confusing to both students and the general population. Environmental problems can be very complex, and they interconnect in many ways, and this complexity leads to misunderstandings. Because the students of today will become the voting citizens of tomorrow, it is important that instruction on environmental issues be increased and enhanced so that citizens are able to make intelligent decisions for their personal lives

and for society in general.

Boyes, Chuckran, and Stanisstreet (1993) conducted a research study involving 702 students (49.7% females, 50.3% males) ranging from grades 5 to 10 across the curriculum from five schools. Students were issued the Environmental Issues Questionnaire which contained 36 statements with Likert Scale choices and ten questions pertaining to demographics. Using factor analysis, common themes in the thinking of the students surfaced. Results (25,272 responses) indicated that many students appeared to confuse certain major environmental problems: global warming, the greenhouse effect, ozone depletion, loss of biodiversity, air and weather pollution, and other problems.

One difference in students found by the study was that their level of understanding changed over the years, with scores generally improving for older students. They found that older students have a more positive attitude to nuclear power issues when relating to the greenhouse effect. However, many students believed that protection of rare species would reduce global warming, and this misconception did not diminish with age. Also, older students were more likely to believe that using lead-free gasoline would reduce the greenhouse effect, and many thought that acid precipitation contributes to global warming.

This new study focused on the idea that a portion of student misconceptions may arise from incorrect instruction by teachers who themselves hold incorrect views. Therefore, this study

followed up the first study by examining college students in order to see if the level of understanding held by elementary education majors, liberal arts majors, and science majors continues the upward trend in scores, and if the misconceptions identified earlier still occur.

Methodology

The Environmental Issues Questionnaire was administered to 330 undergraduate and graduate students from three domains: education, liberal arts, and science (Pharmacy and Health Sciences students were combined with Pure and Applied Sciences students to make the science domain). The questionnaire contained 36 questions with an additional nine demographics questions (Appendix A). The questions form two subsets: 1 through 24 deal with causes of the greenhouse effect, and questions 25 through 36 focus on ways to alleviate the problem.

The questionnaire was administered during the 1994-95 academic year to students at Northeast Louisiana University. The nine demographic questions deal with: 1) gender, 2) class level, 3) college assignment, 4) teaching background, 5) GPA, 6) age, 7) race/ethnic group, 8) state residency, and 9) highest earned degree. Both t-test and Scheffe' ANOVA were employed for data analysis.

Results

The means and standard deviations for the three college domains (education,liberal arts, and science) are in Table Ia. The mean for education was 15.31 (sd = 5.34), for liberal arts

the mean was 15.32 (sd = 5.80), and for the science domain (Pure and Applied and Pharmacy), the mean was 16.19 (sd = 5.08). The mean for all three domains combined together was 15.56 (sd = 5.35).

Gender analysis:

Gender analysis revealed that, for students overall, males scored higher than females ($p \leq .01$). Males scores were higher at the $p \leq .05$ level for questions regarding causes of the greenhouse effect (#1 - #24), and were higher at the $p \leq .001$ level for questions on ways to alleviate the greenhouse effect (#25 - #36). Comparisons within colleges produced the following results:

1) Education - no significant differences.
2) Sciences - significance (.01 level) for questions #25-#36.
3) Liberal Arts - no significant differences.

Comparisons of males across the three colleges produced no significant differences. Females in the College of Pure & Applied Sciences scored significantly higher ($p \leq .008$) than their counterparts in the College of Pharmacy and Allied Health Sciences, but only for questions #25 - #36. There were no other significant differences for females across colleges.

Class level: Overall, graduate students scored significantly higher than did the undergraduates on questions #1 - #24 (.01 level), but significance was only at the .075 level for questions

#25 - #36. Within college comparisons produced these results:

1) Education - Both question subsets showed graduate students higher ($p \leq .04$).
2) Sciences - No significant differences.
3) Liberal Arts - No significant differences.

College assignment:

The college domains were compared with the accepted answer as either of the first two choices of the Likert Scale (i.e. "A & B" or "D & E"). A Scheffe ANOVA showed that the science majors scored higher than the education students ($p \leq .05$) for questions #25 - #36, with no other significant differences. There were no significant differences for $p \leq .01$.

For the 36 questions, education majors scored at or above 70% on five (#1, 8, 11, 21 and 30), and scored at or less than 30% on 12 (#3, 5, 6, 12, 14, 19, 20, 23, 25, 28, 29, and 33). Ninety-two percent of students correctly recognized that an increase in the greenhouse effect (GE) will cause changes in the world's weather: 80% showed understanding that an increase will lead to the earth getting hotter; and 78% responded correctly for the effects of CFC gases and planting of trees. Ninety-five percent of the students accepted the statement that the GE is made worse by holes in the ozone layer; 87% agreed with the statement that the GE can be made smaller by using unleaded gasoline; 86% agreed that the GE is increased by too many sun's rays getting to earth; 85% agreed that radioactive wastes can

increase the GE; and 83% accepted the idea that an increase in the GE will cause more people to get skin cancer.

Teaching background: No significant differences were found between elementary education undergraduates and all other teaching backgrounds.

Grade point average:

Overall, significant difference was found when GPA scores below 2.99 were compared to scores above 3.00 ($p \leq .007$), with most of the significance arising from questions #1 - #24 ($p \leq .004$). However, most of the significance was produced by the College of Education. Science and liberal arts students showed no significant differences for GPA. Specifically, for education majors:

1) Questions #1 - #24: $p \leq .01$
2) Questions #25 - #36: $p \leq .04$
3) All questions: $p \leq .01$

Age: No significant differences for age were found for liberal arts and science majors. Older education majors (27+ years old) scored higher than the younger students, but only for questions #1 - #24 ($p \leq .05$).

Race/ethnic group: In the College of Education, white students scored higher than black students on questions #25 - #36 ($p \leq$

.003), but their performance on the causal questions (#1 - #24) was non-significant.

For the science majors, whites scored higher only on questions #1 - #24 ($p \leq .03$). There was insufficient data to generate results for the liberal arts majors. Small numbers of black students were also a problem for the other two colleges, so this data may not be reliable.

State residency: Louisiana students were compared with students from other states to see if any differences possibly related to high school science experiences existed. For all three colleges, no significant differences were found.

Highest earned degree: The education majors were the only group to have sufficient data for comparisons, and only questions #24 - #36 produced a possible difference ($p \leq .077$), with undergraduates and Bachelor's degree holders scoring lower than students with Master's degress or higher.

Conclusions

Gender analysis revealed that overall, males outscored females. This may be due to a tendency for women to choose the "I don't know about this" position more often than do men, even when they actually do know the subject. Thus, the true knowledge level of women may not be represented by these results. It should be noted that there was no significant differences between

male and female education and liberal arts majors. Only science majors showed a clear gender difference, and then, only on questions #25 - #36. This suggests that college men are more knowledgeable than college women regarding ways to alleviate global warming problems, but the study was not able to uncover any clear reasons for this.

That science students scored significantly higher than the education majors is not surprising due to the greater exposure to science content. However, liberal arts majors did not score significantly different from the science majors. This is encouraging, since it suggests that their training provides them with an awareness of environmental issues that is similar to that of science majors.

For class level, GPA, age, and highest degree earned, significant differences were found for education majors, but not for science and liberal arts majors. This suggests that science and liberal arts students, as groups, are more homogeneous than are the education majors. Class level, age, and highest degree earned are certainly related, because most of the graduate students are older than the undergraduates, and degree earned directly relates to student position as graduate or undergraduate. It is encouraging to find that higher GPA correlates with better performance on the survey. The education majors do not differ significantly from their peers in the other two colleges on GPA because they must have GPA's of at least 2.50 in order to be admitted into the Teacher Education Program, while

upper division students in the sciences and liberal arts only need a 2.00 GPA.

Residency was examined to see if student origin had an effect on performance. Louisiana students regularly score low compared to students in most other states. However, Louisiana students scored the same as did students from other states. There were too few international students to determine if this group was different from Louisiana students.

Data on race/ethnic groups was scanty: white education majors scored higher than blacks on questions relating to ways to alleviate greenhouse effect problems, and white science majors scored higher on questions relating to causal effects, but the small numbers of minority students make these results untrustworthy.

No significant differences were found between elementary and secondary education (non-science) majors, and this parallels the lack of significance between education and liberal arts students, since the non-science secondary education students have degree programs that are similar to that of liberal arts majors.

Implications

That education majors correctly recognized some of the major potential effects of global warming is encouraging, but the confusion of this problem with other issues like ozone depletion, radiation pollution and nuclear bombs, acid rain, earthquakes, biodiversity and water pollution is alarming. If education majors do not have an appropriate understanding of these

environmental issues, then they may spread this confusion to their students. These results may reflect a more general problem of "science illiteracy" - these students, and the ones examined in the Boyes et al. study, are superficially aware of the environmental issues presented by the questionnaire, but they do not have an adequate conceptual knowledge of them. Environmental issues such as global warming relate to all of the major scientific disciplines, thus students must be able to integrate their learning in the various science courses in order to better understand the complexities involved. However, many students are not exposed to integrative approaches to science, thus they do not develop the skills and knowledge necessary to effectively deal with such complex issues. The National Science Education Standards (1996) recognizes this problem, and presents a strong argument for much greater emphasis on integrated approaches. Hopefully, if both K-12 and post-secondary education systems can successfully redirect their curriculums toward these science education reforms, then chances for true science literacy will improve, and society will benefit by citizens being able to make more informed decisions concerning the serious environmental problems facing us.

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